multiple chemicals." Thus the OSHA standard reverted back to 100 ppm. The EPA rule calls for a reduction in perc emissions and is the first national emissions standard for hazardous air pollutants (NESHAP) issued by EPA to regulate 189 toxic chemicals under the 1990 Clean Air Act.

The new EPA rule applies to businesses that gross more than $75,000 a year and bans new purchases of transfer machines, which consist of separate washers and dryers. All cleaners are required to install dry-to-dry machines when existing equipment is replaced, which combine washing and drying in the same place and emit considerably less perc. EPA expects the rule will cut fugitive perc emissions in half. For large dry cleaners that potentially emit 10 tons of perc a year, room enclosures will be required for transfer operations of solvent-laden clothes from washers to dryers.

According to the U. S. International Trade Commission, nearly 242,000 pounds of perc were produced and used in the United States in 1992. In the first half of 1993, close to 154,000 pounds were manufactured, representing a 27% increase. In addition to use as a dry-cleaning solvent, perc is used for metal degreasing, as a general solvent, and has been used against nematodes and trematodes in animals and humans.

According to an EPA source, the agency considered seeking an extension of the court deadline for the final rule to more fully investigate perc issues. However, administrators believed such a delay would have postponed the health and environmental benefits of the rule for an extended and unacceptable period of time. EPA determined that the best environmental protection would be achieved by issuing the rule as expeditiously as possible and deciding subsequently how to best address remaining indoor air pollution and groundwater contamination associated with perc dry cleaners. To that end, EPA convened a public meeting November 3–4 at the New York-Pennsylvania Hotel in New York, which was attended by 90 people.

Lyme Vaccine Makes Outdoors Safe Again

Lyme disease has stricken 50,000 Americans since it was discovered in 1976. Now a group of researchers at Yale University have developed a vaccine against Lyme disease that may allow people living in high-risk areas to again enjoy the outdoors.

"You constantly have to think about it; you worry when your grandchildren go outside, and do tick checks every night," said Ellen Jacko of Block Island, Rhode Island, where the vaccine will be tested. "I'm old enough to remember polio. It reminds me of the way parents were afraid to let kids go into the swimming pool."

Although Lyme disease is easily treated early in the course of the illness, its first symptoms are often overlooked. In later stages Lyme can produce neurologic problems, arthritis, and abnormal heart rhythms. Alan Elwell, a resident of Block Island, said that one of his sons missed a year of school due to paralysis from Lyme and a second son was rushed to the hospital with heart problems from the disease. "We all have our horror stories," he said.

The disease is a major problem in areas where ticks, small rodents, and deer are prevalent. Many people in the coastal Northeast have been infected, as well as people in parts of New Jersey, California, and Minnesota. On Block Island, which is mostly wild and undeveloped and is home to more than 700 deer, 1 in 20 people contract Lyme disease each summer.

Because people who contract Lyme disease and recover without the aid of antibiotics are immune to subsequent infections, researchers knew it was possible to develop a vaccine. The problem was that some of the worst symptoms of the disease were believed to be due to an over-agressive immune response, making it impossible to use the whole spirochete organism to produce the vaccine.

Researchers quickly focused their attention on a protein of the spirochete that causes Lyme. The protein, called OSP-A, was isolated, its gene cloned and inserted into *E. coli*, and the protein mass produced by the bacteria. Tests in animals showed that the vaccine made from this protein not only cured the disease, it cured any infected ticks on the animal.

"This is a vaccine that works in a unique way," said Andrew Spielman of the Harvard School of Public Health. "It kills the organism in the gut of the tick when it ingests a blood meal."

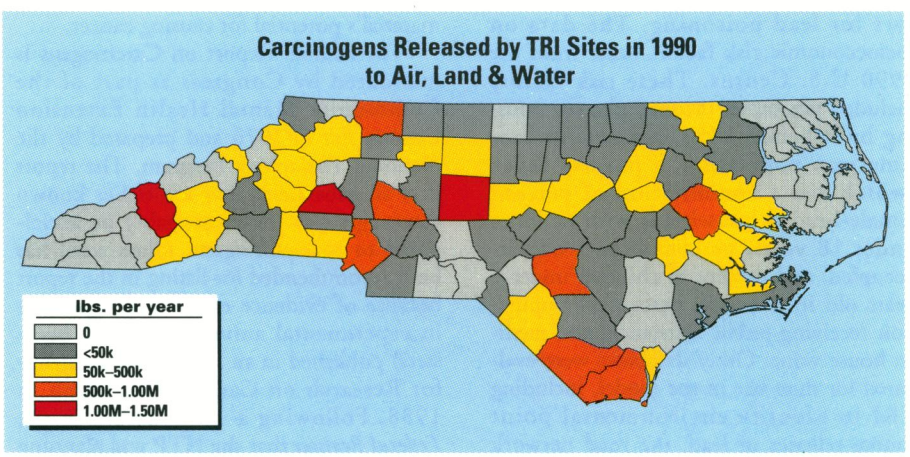
So far, testing suggests that the vaccine does not provoke aberrant immune reactions thought to contribute to Lyme arthritis and neurologic effects of the disease such as Bell's palsy, a temporary paralysis of the facial muscles. Although some people treated with the OSP-A vaccine have produced unusually high levels of antibodies, Fred Kantor of Yale University believes that these high levels of antibodies simply indicate that such people have been infected for a long time and have organisms in areas of their bodies where the immune system cannot get to them.

"Could the vaccine cause a chronic relapsing disease or an adverse reaction?" said Kantor. "I suppose it could, but the evidence is that it doesn't happen. I feel the chances of a problem are remote enough that I will be happy to take it."

Mapping out Health

Researchers at NIEHS have been exploring a system that uses geographic information for environmental health research. A geographic information system (GIS) may potentially be used to characterize environmental exposures in relation to demographic variables for specific population groups, identify populations at high risk for environmental disease to target prevention programs, and analyze environmental epidemiological data to generate or test specific hypotheses. A recent seminar organized by NIEHS and the North Carolina Department of Environment, Health and Natural Resources (NCDEHNR) brought researchers from local universities and other organizations together to discuss research involving GIS.

A GIS can be defined as a computer system of hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling, display (mapping), and output of data by geographic location. For any application there are five generic questions that



Brent Cooke

Toxic towns. Geographic information systems enable researchers to follow trends in environmental health.

a GIS can answer: What is at a particular location? Where is a location that meets a particular condition? What has changed at the location since a specific time or event? What spatial patterns exist? What if specific events occur or a population is exposed? Many of these applications are useful for environmental health research.

Using GIS to describe potential environmental exposures by location, race, and socioeconomic factors within specific population groups is essential to documenting problems related to environmental equity. NIEHS has begun a GIS project to identify and gather environmental exposure and demographic databases to examine this issue. Examples of exposure databases include several EPA files such as the Toxic Releases Inventory (TRI), which includes yearly data on the release of 300 toxic chemicals, and CERCLIS and RCRIS, which include information on the location of waste sites. The demographic information is contained in the 1990 U.S. Census. Exposure databases include spatial information that allows for an analysis of potential toxic exposures by state, county, and census block groups and can be correlated with the available census variables including race and income level. Currently, these analyses are being carried out in several North Carolina counties as well as counties in California and West Virginia. The results will be presented at the "Symposium on Health Research and Needs to Ensure Environmental Justice," scheduled for February 10–12 in Washington, DC.

Last year NIEHS funded a study conducted by the NCDEHNR that took advantage of GIS methodology to identify populations at high risk for childhood lead poisoning. In this study, numerous risk factors with spatial identifiers known to be related to childhood lead poisoning were identified and entered into a model to highlight geographic areas that contain environmental and socioeconomic risk factors for lead poisoning. The data on socioeconomic risk factors came from the 1990 U.S. Census. These risk factors included per capita income, percent housing built before 1950, percent African-American population, a poverty index (which was a combination of percent female-headed households with children under 18 years, percent homes owner-occupied, and percent of children under 6 years old in poverty), percent of population receiving public assistance, and median house value. Other databases were evaluated for their use in the model, including TRI to identify environmental point source releases of lead, the road network system to identify proximity to major roads, and EPA's STORET and AIRS databases, which include water and air quality data. The analysis was performed for several counties within North Carolina down to the census-block group level. The results yielded a spectrum of low- to high-risk block groups within the counties. This methodology needs to be validated in the field by sampling predicted high- and low-risk populations and comparing the actual risk measured by blood lead levels with the risk predicted by the model.

Although GIS has not been used extensively in environmental epidemiology, studies to generate and test hypotheses are beginning to emerge. As environmental exposure databases compatible with GIS are developed, linkages will be possible with health and disease data. Much of the health and disease data can be related to spatial/geographic variables; this primarily involves the use of addresses of residence or information to identify census tract or block, county, or zip code. Databases of interest include cancer and birth defects registries, mortality files, hospital discharge files, and other survey data or registries. The NCDEHNR has embarked on several environmental epidemiologic studies using GIS. One such study includes an analysis of brain cancer (from the North Carolina Cancer Registry) and proximity of residence to electric power lines (surrogate of exposure to electric and magnetic fields). Examples of other studies that might be considered include childhood asthma related to environmental exposures, breast cancer related to environmental and demographic factors, and birth defects related to living near hazardous waste sites.

Through a Glass, Darkly

Lately it appears that even a substance as ubiquitous as glass wool (fiberglass) is not insulated from controversy. The potential listing of glass wool in the Seventh Annual Report on Carcinogens has government and industry scientists at odds over the material's potential for causing cancer.

The Annual Report on Carcinogens is mandated by Congress as part of the Community Mental Health Extension Centers Act of 1978 and prepared by the National Toxicology Program. The report lists all substances that are either known carcinogens or may reasonably be anticipated to be carcinogens. Glass wool has been recommended for listing in the report because of evidence of its carcinogenicity in experimental animals (rats and hamsters) published in an International Agency for Research on Cancer monograph in 1988. Following a 1990 notice in the *Federal Register* that the NTP was planning to list glass wool in the annual report, the North American Insulation Manufacturers Association (NAIMA) submitted several petitions to the Secretary of Health and Human Services requesting a deferral of the listing pending a reexamination of the scientific studies assessing the carcinogenicity of glass wool and review of the criteria used by the NTP to list substances. A reexamination and review are underway.

Currently the criteria for listing a substance in the Annual Report on Carcinogens are based on those used by IARC for classifying carcinogens. For a substance to be considered a known carcinogen, the criteria are "sufficient evidence of carcinogenicity" from studies in humans "which indicates a causal relationship between the agent and human cancer." For a substance to be reasonably anticipated to be a carcinogen, the criteria are "limited evidence of carcinogenicity" from studies in humans, "which indicates that causal interpretation is credible, but that alternative explanations, such as chance, bias, or confounding, could not adequately be excluded," or "sufficient evidence of carcinogenicity" from studies in experimental animals "which indicates that an increased incidence of malignant tumors in multiple species or strains, or in multiple experiments (preferably with different routes of administration or using different dose levels), or to an unusual degree with regard to incidence, site or type of tumor, or age at onset." Additional evidence may be provided by data concerning dose–response effects as well as information on mutagenicity or chemical structure.

The controversy surrounding the listing of glass wool concerns whether inhalation studies in the rodents are the only appropriate model in rats by which to evaluate glass wool's carcinogenic potential in humans. The bone of contention between government and industry is the route of exposure to glass wool by which rats are subjected during testing. The rat is an obligate nose breather, whereas humans breathe through the nose and mouth. In addition to inhalation studies, rats and hamsters were given intraperitoneal injections and intratracheal instillations of glass wool fibers. According to NAIMA, this route of administration artificially places high concentrations of fibers at a target site and avoids the natural defense mechanism of the rat. NAIMA contends that only studies of rodents exposed to glass wool by inhalation should be considered in evaluating its toxicity. Although tumors have been produced in most glass wool inhalation studies in rodents, tumors have not been observed at statistically significant levels when compared to controls.

Intraperitoneal injection studies in rats and intratracheal instillation studies in rats and hamsters have produced significant